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A Discourse on this PROBLEM;

Why Bodies dissolved in Menstrua Specifically lighter than themselves swim therein.

By Mr. *WILLIAM MOLYNEUX*, of *Dublin*.
Member of the *Royal Society*.

The Liberty of Philosophising being now universally granted between all men, I am sure that a difference in Opinion will be no breach of affection between two intirely Loving Brothers : And therefore I shall take the freedom to Propose my Own thoughts in a matter wherein my Brother Mr. Thomas Molyneux hath Appeared publickly in the *Novelles de la Republique des Lettres*, *Mois d' Aout 1684*. *Art 4.* and *Mois de Janvier 1685*. *Art. 7.* The Problem proposed is, *Why Bodies dissolved float in Liquors lighter than themselves*; as for Example : Mercury dissolved in strong Spirit of Nitre swims therein, tho' each small Particle of Mercury, be far heaver than so much of the Liquor whose place it occupies. This, says he, cannot be solved by the prime Law of Hydrostaticks, which is, that a Body which in an equal Quantity is heaver than a like quantity of Liquor, sinks in that Liquor; thus a Cubick Inch of Iron being heavier than a Cubick Inch of *Aqua-Fortis*, and each Particle (how small soever) of Iron being heavier then a like Particle of *Aqua-Fortis*; Iron being put into *Aqua-Fortis* should sink, and yet we find, that Iron being dissolved in a convenient Quantity of *Aqua-Fortis* floats therein, and does not fall to the Bottom. The Reason which my Brother gives for this is, that the Internal Motion of the Parts of the Liquor, does keep up the Particles of the dissolved

solved Solid, for they being so very Minute, are Moveable by the least Force imaginable, and the Action of the Particles of the *Menstruum*, is sufficient to drive the Atomes of the dissolved solid Body from place to place; and consequently, notwithstanding their Gravity, they do not sink in the Liquor lighter than themselves. As a Proof of this in the 7th Article of Janvier 1685, he offers an Experiment known in *Chymistry*, that a *Menstruum* over a digesting Fire (as the *Chymist* speaks) will dissolve a greater Quantity of a Body put into it, than when 'tis off the Fire, and if it be taken off the Fire, and suffered to cool, a great Portion will precipitate of that which was perfectly dissolved, whilst the *Menstruum* continued hot. For, *says he*, the Particles of the *Menstruum* acquire a more violent agitation by the Fire, and are therefore able to raise and keep up a greater Quantity of the dissolved Body, or hereby they are able to Resist a greater Gravity.

It has been objected against this Notion, that the common Experiment of precipitation, by mixing an *Alkaly* with an *Acid*, seems to contradict this; for thereby the Fluidity of the *Menstruum* is not taken away, and consequently, the internal Agitation of its Parts is not diminished, and yet thereupon, the Particles of the dissolved Body precipitate all to the Bottom. To this he answers in the forecited Article of January, that all Mixtures of different Liquors introduce in each a different Conformation of Pores, and therefore the Infusion of a new Liquor, drives the insensible Parts of the dissolved Body from their Places, and forces them to strike against each other, and cling together, and so becoming more big and heavyer than formerly, the internal Agitation of the Liquor is no longer able to move and sustain them, and consequently they fall to the Bottom.

This, as fairly and shortly as I can propose it, is his Sentiment of this Phænomenon.

But I conceive another Account may be given of this Appearance, and that the foresaid Law of *Hydrostaticks* is a little deficient. 'Tis true indeed, if we consider only the specifick Gravity of a Liquor, and the specifick Gravity of a solid Particle floating therein, the forementioned Rule is exact ; but in sinking there is a requisite separation of the Parts of the Liquor by the sinking Body ; and there being a natural Inclination in the Parts of all Liquors to Union, arising from an Agreement or Congruity of their Parts, there is a resistance therein to any thing that separates this Conjunction : Now unless a Body have weight enough to overcome this Congruity or Union of Parts, such a Body will float in a Liquor specifically lighter than it self. But that a heavy Body, as *Mercury* or *Iron* may have its Parts reduced to that Minuteness, that their Gravity or Tendency downwards, is not strong enough to separate the Cohesion or Union of the Parts of a Liquor, will be manifest, if we consider, that the Resistance made by the *Medium* to a falling Body, is according to the Superficies of the Body ; but as the Body decreases in Bulk, its Superficies does not proportionably decrease ; thus a Sphere of an Inch Diameter, has not eight times less Superficies than a Sphere of two Inches Diameter, tho' it have eight times less Bulk, and consequently passing through a *Medium*, as suppose Air or Water, the Sphere of an Inch Diameter is, proportionably to its Bulk, more resisted, than a Sphere of two Inches Diameter in proportion to its Bulk ; and hence it will come to pass, that at last a Body may be reduced to that Minuteness, that its Gravity pressing downwards (which is according to its Bulk) may be less than the resistance of the *Medium*, which operates on the Surface of the Body ; seeing as I said before, the Surfaces of Bodies do not decrease so fast as their Bulks, these decreasing in a *Triplicate*, but those in a *Duplicate Ratio* of the Bodies Diameters.

This Account does not at all oppose the Experiment of a *Ministrum* over the Fire, being able to dissolve or sustain

a greater Quantity of a heavy Body ; for the Reason of this, as 'tis given by my Brother, does not Contradict my Notion. The Account likewise, that He gives of Chymical Precipitation agrees very well with what I propose : So that of these I shall say no more.

But because in the beginning of my Discourse, I say that the forementioned Law of *Hydrostaticks* is a little defective, I desire to explain my self a little further in that Point. In Weights falling through the Air, were Gravity only consider'd, the Proportions of their Descents would be exactly as *Galileo* has Demonstrated ; but it is allow'd by all, that the Resistance of the Air, not being consider'd in those Demonstrations, they are not Mathematically true in Practice, but that Really there is something of that Proportion hindred by the Airs Resistance. Now, what is this less than to say, that the Resistance of the Air takes off some of the Operation of Gravity, or is able to withstand or oppose part of its Action ? And if so, what shall we say, were an Iron Sphere let through a Medium of Water ? Surely the Proportions of its descents would be much more disturbed herein, as Water is much more solid and difficult to be separated or pass'd through than Air, and consequently we must needs Grant, that more of the Operation of Gravity, is taken off or Resist'd by this Opposition of the Water, than that of the Air. And if so, Surely there may be a certain degree of Gravity, that may be quite taken off by the Resistance of the Water : Were a Pistol Bullet let fall through the Air, it would Descend imperceptibly nigh the Proportions that *Galileo* has assigned, but were a single grain of Sand so let fall, it would be much hindred in its Course, and the half of this Grain would be more obstructed ; what shall we then say of the ten thousandth part, or of a part the ten thousand millionth of this, and again of the Infinite Subdivisions of that, till at last we come to a part that would be wholly resist'd, or kept up ;

such as I conceive the Minute particles of a Body dissolved in a *Menstruum*.

On this account 'tis I say, that the forementioned Principle of *Hydrostaticks* is a little defective; for it considers not the Natural Congruity of the Parts of a Liquor, whereby they desire, as 'twere, to unite and keep together, just as we see two Drops of Water on a Dry Board being brought together do jump and Coalesce, and therefore Liquors have an innate Power of Resisting a certain degree of force that would separate them; such as I suppose the degree of Gravity in the most Minute Particles of a Body dissolved in a *Menstruum*.

The forementioned Rule holds true to the most nice Sense in Great Bodies but in those that are by many Millions of Divisions Smaller, it seems to fail.

This in short is my Conjecture in this matter, which I propose, as my Brother did his, with all submission imaginable, and thereby to give occasion to others to enquire into the Causes of this appearance, rather than to publish my own sentiment, as the undoubted solution thereof.

But this I must acknowledge, that the Internal motion of the parts of a Liquor seems so very agreeable to truth, and expicates so many Phænomena easily and plainly, that I would not be thought to deny it. Neither would I be thought wholly to Reject my Brothers solution of this Problem; for certainly that Motion (whatsoever it is) in a *Menstruum*, which is able to Dissolve such a solid Body as Iron, that is, which is able to disturb the close and strong Cohesion of the Parts of Iron, may very well be supposed sufficient to disturb or keep up these parts from resting in the Bottom of the Vessel, wherein the solution was made; And certainly no better account can possibly be given of such solutions, than by supposing such an Internal motion in the Parts of the *Menstruum* insinuating themselves into the solid body, and loosening its Parts. And tho' it may be objected, that in the Parts of Water there may be supposed

as Violent an Internal motion, as in the Parts of *Aqua-Fortis*, and yet we see Water will not dissolve Iron, as *Aqua-Fortis* does, and Common Bees-Wax is disturbed by neither of them, I leave the Nice Enquiry after this point to others, viz. What kind of Motion and peculiar Conformation of parts is requisite both in the *Menstruum* and in the Dissolved Body, that a solution may result from their Commixture.

Some Reflections on the foregoing Paper by Mr. T. M.

What my Brother has laid down in this Discourse, I think does most undeniably evince that the received Law of *Hydrostaticks* is somewhat defective. For Liquors, tho' they are Fluid yet they are Bodies, and therefore consist of parts united; which Union tho' it be easily destroy'd, yet of necessity it requires some degree of Force for the effecting it; nor is it more manifest, if rightly consider'd, that a Flint requires Force for the separation of its parts, than that Fluids do for theirs. But however, I imagine, this Property ought not to be rely'd upon as the sole Cause of this Appearance, to which my Brother has apply'd it; nay perhaps does not so much as concur the least in the producing this effect; my Reason in short is this: whatever is of sufficient Power to raise the minute Particles of a *Heavy Body* in a light Fluid, is certainly a sufficient cause to keep them in that state: now my Supposition may give some account of this; what my Brother says, never can; for he must necessarily suppose them first raised; and then he gives the reason of their not sinking: Whereas 'tis not to be questioned but that that Force which raised them, is the same that keeps them from falling to the bottom.

But these Conjectures (for I esteem them no more) I leave to the Consideration of those that desire to enquire further into this Matter.